Income Tax-Cum-Consumption Tax Schedules as Stabilization Policy

Juin-jen Chang, Institute of Economics, Academia Sinica and Fu-Jen Catholic University, Taiwan

Chia-ying Liu, Department of Economics, Aletheia University, Taiwan

Chi-hsin Wu, Department of Labor Relations, National Chung Cheng University, Taiwan

January 2011

Abstract: In a Benhabib-Farmer-Guo one-sector model, a progressive tax schedule operates like an automatic stabilizer that mitigates business cycle fluctuations, but in an indeterminate two-sector real business cycle model a regressive, rather than a progressive, tax policy stabilizes the economy against sunspot-driven fluctuations. Given that the required regressive tax policy is not empirically plausible, this paper attempts to propose an alternative policy, namely, the *effective* income tax-cum-consumption tax schedule, to stabilize against sunspot fluctuations in an indeterminate two-sector real business cycle model. To be specific, if, due to strong sectoral externalities, the economy exhibits local indeterminacy, the government can suppress belief-driven fluctuations by implementing a tax switch from a decrease in the income tax rate to an increase in the consumption tax rate. This implies that in addition to its well-known efficiency improvement, a tax switch away from an income tax towards a consumption tax can also serve as a stabilization policy against endogenous business cycle fluctuations.

JEL Classification: E32; E63; O41.

Keywords: Income tax-cum-consumption tax schedules; local indeterminacy; sunspot fluctuations.

* We would like to thank Jang-Ting Guo for his helpful comments and suggestions. The usual disclaimer applies.

Correspondence: Dr. Juin-jen Chang, Institute of Economics, Academia Sinica, Nankang, Taipei 115, TAIWAN, R.O.C. Fax: 886-2-27853946; E-mail: jjchang@econ.sinica.edu.tw

1 Introduction

In the macroeconomic literature, there have been a vast number of articles that have established the existence of indeterminate equilibrium paths. Based on the seminal studies of Benhabib and Farmer (1994) and Farmer and Guo (1994), it is well-known that in a one-sector model with increasing returns to scale, an indeterminate steady state can be generated if aggregate returns to scale are sufficiently strong. Indeterminacy potentially indicates that agents' expectations concerning the future can be self-fulfilling and, as a result, the so-called "animal spirits" may generate business cycle fluctuations without any change in economic fundamentals. This creates room for Keynesian-type stabilization to insulate the economy from belief-driven fluctuations. For example, Grandmont (1986) and Reichlin (1986) argue that government policies through lump sum transfers and public expenditures may help reducing cyclical properties of competitive economy. Guo and Lansing (1998), Christiano and Harrison (1999), and Dromel and Pintus (2007, 2008) propose that, in a Benhabib-Farmer-Guo one-sector model a progressive tax schedule operates like an automatic stabilizer that mitigates business cycle fluctuations, while a regressive tax destabilizes the economy.

This notion, however, is not able to apply to a two-sector model of Benhabib and Farmer (1996) with sector-specific externalities. In a calibrated two-sector real business cycle (RBC) model with only sector-specific externalities, Guo and Harrison's (2001) quantitative analysis shows that (i) a progressive tax no longer serves as an automatic stabilizer, removing sunspot fluctuations, and (ii) by contrast, a regressive tax policy stabilizes the economy against sunspot-driven fluctuations. This paper attempts to propose an alternative policy, rather than the income-dependent (progressive/regressive) tax schedule, to stabilize against sunspot fluctuations in an indeterminate two-sector RBC model. To this end, we extend the two-sector (consumption and investment sectors) model of Benhabib and Farmer (1996) by considering an income tax-cum-consumption tax schedule.[1] A particular emphasis is that, on the one hand, the required regressive tax policy that Guo and Harrison (2001) find is neither empirically plausible nor is observed in the actual data, hence we consider "flat" tax rates. On the other hand, either a single constant income tax rate or a single constant tax consumption tax rate *cannot* have a stabilizing effect, thereby suppressing sunspot fluctuations. Therefore, we need to consider the "combination" of income and consumption taxes (or the income tax-cum-consumption tax schedule).

In this paper, we perform both analytical and numerical analyses in order to provide more policy

[1] By using different models with the good and education sectors, Devereux and Love (1995), Wang and Yip (1995), and Bond *et al.* (1996) have analyzed the relationship between macroeconomic instability and factor taxes.

implications. To be specific, we show that an *effective* income tax-cum-consumption tax schedule can insulate the economy from belief-driven fluctuations. If, due to strong "sectoral externalities," the economy exhibits local indeterminacy, the government can suppress belief-driven fluctuations by implementing a tax switch from a decrease in the income tax rate to an increase in the consumption tax rate.[2] Why can such an income tax-cum-consumption tax schedule be an effective tool for establishing macroeconomic stability when the economy exhibits not only aggregate increasing returns, but also sector-specific externalities? The rationale is the following. When agents anticipate a higher future rate of return on capital, they will reduce consumption for more investment, thus increasing the future capital stock. Meanwhile, if there are high enough sectoral externalities, the rate of return on capital will rise due to a fall in the relative price of investment goods. Thus, agents' optimistic expectations become self-fulfilling. Intuitively, to successfully suppress sunspot fluctuations, the government's policy has to prevent agents from cutting consumption for more capital accumulation and to reverse the downward trend in the relative price of investment goods. This study indicates that tax shifting away from an income tax towards a consumption tax can increase both output and consumption.[3] An increase in the consumption tax gives rise to a negative effect on consumption, but a reduction in the income tax gives rise to a positive wealth effect which raises output and hence consumption as well.[4] Since the wealth effect dominates, consumption increases following such a tax shifting. It turns out that consumption is enhanced and, given a convex production possibility frontier, the relative price of investment goods rises in response. As a result, the future marginal product of capital decreases and thus the tax switch prohibits agents' optimistic expectations from being self-fulfilling. It is important to note that since tax shifting away from an income tax towards a consumption tax increases both output and consumption, in our model consumption is procyclical in relation to output. This relationship is in accordance with the data on business cycles in most countries.

The tax reform involving a switch from a decrease in income tax to an increase in consumption tax has been an important issue in public finance and macroeconomics over the past three decades.

[2] Giannitsarou (2007) argues that the economy can be immune from sunspot fluctuations caused by a balanced budget rule, if the government finances it expenditures via an endogenous consumption tax.

[3] As a common specification in the relevant literature, in our model the consumption tax rate is viewed as an exogenous policy parameter, while the income tax rate is an endogenous variable, which ensures a balanced government budget.

[4] Given that consumption tax involves less distortion than income tax to economic efficiency, some studies have argued that, as a result of a strong wealth effect, such a tax switch results in either a higher level of output (Chamley, 1985) or a higher rate of economic growth (Pecorino, 1993, 1994 and Turnovsky, 2000).

Many studies, such as Atkinson and Stiglitz (1976), Summers (1981), Abel and Blanchard (1983), Auerbach et al. (1983), and Chamley (1985), have pointed out that a consumption tax could result in less distortion than an income tax and could eliminate the bias against investment and savings inherent in the income tax system. Therefore, such a tax shift will improve economic efficiency and social welfare. As an important complement, our finding suggests that in addition to its efficiency improvement, a tax switch away from an income tax towards a consumption tax can also serve as a stabilization policy against endogenous business cycle fluctuations.

The remainder of the paper is arranged as follows. Section 2 presents our analytical framework. Section 3 analyzes the (in)determinacy properties. In Section 4, we show how an effective income tax-cum-consumption tax schedule can suppress aggregate instability arising from animal spirits. Section 5 concludes.

2 The Model

The model is an extension of Benhabib and Farmer (1996) in which we consider the government's income tax-cum-consumption tax schedules. Consider an economy consisting of households, firms and a government. Households derive utility from consumption and leisure. On the production side, there are two sectors – the consumption good and investment good sectors. The typical firm in each sector produces with a constant returns-to-scale technology and has access to sector-specific and economy-wide externalities. The government levies income and consumption taxes to finance its spending. Of importance, the government will attempt to design an effective income tax-cum-consumption tax schedule in order to stabilize the economy against sunspot fluctuations.

2.1 Firms

Each consumption and investment good is produced by a decentralized competitive sector and by using capital K_t and labor L_t in competitive factor markets. The production technologies of a typical firm in the consumption good and investment good sectors are, respectively:

$$Y_{C,t} = A_t(K_{C,t})^a(L_{C,t})^b \text{ and } Y_{I,t} = B_t(K_{I,t})^a(L_{I,t})^b, \text{ with } a+b=1, \tag{1}$$

where $K_{C,t}$ and $L_{C,t}$ ($K_{I,t}$ and $L_{I,t}$) denote the capital and labor services in the consumption (investment) sector. In line with Benhabib and Farmer (1996), A_t and B_t represent productive externalities in the consumption and investment sectors, respectively, which are given by:

$$A_t = [\bar{K}^a_{C,t}\bar{L}^b_{C,t}]^\theta(\bar{K}^{a\sigma}_t\bar{L}^{b\gamma}_t) \text{ and } B_t = [\bar{K}^a_{I,t}\bar{L}^b_{I,t}]^\theta(\bar{K}^{a\sigma}_t\bar{L}^{b\gamma}_t), \tag{2}$$

where the relevant variables with a bar "–" denote the sector and economy-wide average levels, θ represents a measure of sector-specific externalities, and the parameter σ (γ) measures the aggregate capital (labor) external effect. Let $\mu_{K,t}$ and $\mu_{L,t}$ be the fractions of capital K_t and labor L_t used in the consumption good industry. Thus, the relative factor intensities are: $\mu_{K,t} = K_{C,t}/K_t$ and $\mu_{L,t} = L_{C,t}/L_t$.

The first-order conditions for profit maximization of the consumption good producer are:

$$r_t = aY_{C,t}/K_{C,t} \text{ and } w_t = bY_{C,t}/L_{C,t}. \tag{3}$$

Similarly, in the investment sector the first-order conditions for profit maximization are:

$$r_t = aP_tY_{I,t}/K_{I,t} \text{ and } w_t = bP_tY_{I,t}/L_{I,t}, \tag{4}$$

where P_t is the relative price of the investment good to the consumption good. Given that firms use identical technologies and face equal factor prices across the two sectors, factor intensities are also identical across these two sectors, i.e., $\mu_t = \mu_{K,t} = \mu_{L,t}$. Accordingly, the production possibility frontier (PPF) can be expressed as follows:

$$Y_t = Y_{C,t} + P_tY_{I,t} = A_tK_t^aL_t^b. \tag{5}$$

By defining $S_t = 1/\mu_t$ (which satisfies $S_t \in [1, \infty]$), it is clear from (3)-(5) that the relative price $P_t = A_t/B_t = (S_t - 1)^{1-v}$ (where $v \equiv 1 + \theta$ (> 1)) is also the slope of PPF. If there are no externalities, A_t and B_t are constant and, hence, PPF is linear. As emphasized by Benhabib and Farmer (1996), the inverse of the factor share going to the consumption sector will be a key variable in terms of determining the dynamics of a competitive equilibrium.

2.2 Households

The economy is populated by a unit measure of identical infinitely lived households. A representative household acts to maximize the following discounted present value of a utility function which is separable in consumption and leisure:

$$\max \int_0^{\infty} [\ln C_t - \frac{L_t^{1+\chi}}{1+\chi}]e^{-\rho t}dt, \tag{6}$$

where ρ is the subject discount rate and χ is the inverse of the labor supply elasticity. Given that the law of motion for capital is $\dot{K}_t = I_t - \delta K_t$, the budget constraint faced by the representative household is given by:

$$\dot{K}_t = \frac{1}{P_t}[(1-\tau_Y)(w_tL_t + r_tK_t) - (1+\tau_C)C_t] - \delta K_t, \tag{7}$$

where τ_Y is the income tax rate and τ_C is the consumption tax rate. It is easy from (3)-(5) with factor aggregation constraints to show that $Y_t = w_t L_t + r_t K_t$ holds true in (7).

The optimal conditions necessary for the household optimization problem are:

$$\frac{1}{C_t} = \frac{B_t \Lambda_t (1+\tau_C)}{A_t}, \tag{8}$$

$$L_t^{\chi} = \frac{b(1-\tau_Y) A_t K_t^a L_t^{b-1}}{C_t(1+\tau_C)}, \tag{9}$$

$$\dot{\Lambda}_t = (\rho+\delta)\Lambda_t - \frac{a(1-\tau_Y) A_t K_t^{a-1} L_t^b}{C_t(1+\tau_C)}, \tag{10}$$

together with the transversality condition, $\lim_{t\to\infty} \Lambda_t K_t e^{-\rho t} = 0$, where Λ_t is the co-state variable which can be interpreted as the shadow value of the capital stock, measured in utility terms. Equations (8) and (9) refer to the optimal conditions for consumption and labor, respectively. Equation (10) is the Euler equation of the shadow price of wealth.

2.3 Government

The government collects tax revenues from income and consumption taxes in order to finance the government expenditure, denoted as G_t. Thus, the government budget constraint is given by:

$$\tau_Y Y_t + \tau_C C_t = G_t. \tag{11}$$

To focus on our point and for simplicity, the government expenditure is assumed to be wasteful and is not valued by private agents. Instead, the government attempts to design an effective income tax-cum-consumption tax schedule in order to stabilize the economy against sunspot fluctuations. To the end, the stabilization policy may involve a tax switch, namely, shifting tax away from an income tax (a decrease in τ_Y) towards a consumption tax (an increase in τ_C). To balance its budget constraint (11), when the government changes the consumption tax rate, the income tax rate must endogenously adjust. That is, the consumption tax rate τ_C is viewed as an exogenous policy parameter, while the income tax rate τ_Y is an endogenous variable, which ensures a balanced government budget. Moreover, in line with Barro (1990), the government's expenditures are set as a fraction g of output, i.e., $G_t = gY_t$, for analytic convenience.

In addition, by substituting (11) into (7), the aggregate resource constraint is given by:

$$\dot{K}_t = \frac{1}{P_t}(Y_t - C_t - G_t) - \delta K_t. \tag{12}$$

3 Equilibrium and Dynamic Analysis

A competitive equilibrium is defined as a tuple of paths for quantities $\{C_t, K_t, L_t\}$ and prices $\{P_t, r_t, w_t\}$ such that the maximization problems of the household and firm are solved. Given government policies $\{\tau_Y, \tau_C\}$, the individual and government budget constraints (hence the aggregate resource constraint) are satisfied. Moreover, the market clearing conditions for both sectors are met: $Y_{C,t} = C_t$ and $Y_{I,t} = I_t$.

By some simple manipulations, (8) and (9) can be rewritten as:

$$\frac{1}{C_t} = \Lambda_t(1+\tau_C)(S_t - 1)^{v-1}\,, \tag{8'}$$

$$L_t^{1+\chi} = \frac{b(1-\tau_Y)S_t}{(1+\tau_C)}, \tag{9'}$$

Moreover, based on the definition of S_t and the market clearing condition $Y_{C,t} = C_t$, we obtain:

$$S_t \equiv \frac{1}{\mu_t} = \frac{K_t^{\alpha/v} L_t^{\beta/v}}{C_t^{1/v}}, \tag{13}$$

where $\alpha = a(1+\theta+\sigma)$ and $\beta = b(1+\theta+\gamma)$. Finally, from (10) and (12) with the relative price P_t, we then have the following two differential equations:

$$\frac{\dot{\Lambda}_t}{\Lambda_t} = (\rho+\delta) - \frac{a(1-\tau_Y)S_t}{(1+\tau_C)\Lambda_t K_t}, \tag{14}$$

$$\frac{\dot{K}_t}{K_t} = \frac{[(1-g)S_t - 1]}{(1+\tau_C)\Lambda_t K_t} - \delta. \tag{15}$$

Let the superscript "$\hat{}$" denote the steady-state value for relevant variables. Thus, these six equations (8'), (9'), (11), (13), (14) and (15) with $\dot{\Lambda}_t = \dot{K}_t = 0$ allow us to solve the stationary values of $\left\{\hat{C}, \hat{K}, \hat{L}, \hat{\Lambda}, \hat{S}, \hat{\tau}_Y\right\}$. By substituting (8'), (9'), (11), and (13) into (14) and (15), the dynamical system in our model economy can be reduced to a 2×2 one in terms of Λ_t and K_t.

In line with Benhabib and Farmer (1996), we log-linearize (8'), (9'), (11), (13), (14) and (15) around the steady state values. By defining $\lambda_t = \ln \Lambda_t$, $k_t = \ln K_t$ and $s_t = \ln S_t$, these resulting equations allow us to construct the following 2×2 dynamic system in terms of λ_t and k_t:

$$\dot{\lambda}_t = (\rho+\delta) - \frac{a(1-\tau_Y)e^{s_t-\lambda_t-k_t}}{(1+\tau_C)} \text{ and } \dot{k}_t = \frac{(1-g)e^{s_t-\lambda_t-k_t} - e^{-\lambda_t-k_t}}{(1+\tau_C)} - \delta. \tag{16}$$

In (16), s_t and τ_Y are, respectively, given by:

$$s_t = \eta(k_t, \lambda_t, \tau_C) \text{ and } \tau_Y = \omega(k_t, \lambda_t, \tau_C). \tag{17}$$

where,

$$\frac{\partial s_t}{\partial \tau_C} \equiv \eta_{\tau_C} = \frac{(1-\frac{\beta}{1+\chi})\frac{1}{(1+\tau_C)} + \frac{\beta}{\hat{S}(1+\chi)(1-\hat{\tau}_Y)}}{\nu - \frac{\beta}{1+\chi} + \frac{(1-\nu)\hat{S}}{\hat{S}-1} + \frac{\tau_C\beta}{\hat{S}(1+\chi)(1-\hat{\tau}_Y)}},$$

$$\frac{\partial s_t}{\partial \lambda_t} \equiv \eta_{\lambda} = \frac{1}{\nu - \frac{\beta}{1+\chi} + \frac{(1-\nu)\hat{S}}{\hat{S}-1} + \frac{\tau_C\beta}{\hat{S}(1+\chi)(1-\hat{\tau}_Y)}},$$

$$\frac{\partial s_t}{\partial k_t} \equiv \eta_k = \alpha\eta_\lambda,$$

$$\frac{\partial \tau_Y}{\partial \tau_C} \equiv \omega_{\tau_C} = \frac{-\frac{1}{\hat{S}}[\nu - \frac{\beta}{1+\chi} + \frac{(1-\nu)\hat{S}}{\hat{S}-1}] + \frac{\tau_C}{\hat{S}(1+\tau_C)}(1-\frac{\beta}{1+\chi})}{\nu - \frac{\beta}{1+\chi} + \frac{\hat{S}(1-\nu)}{\hat{S}-1} + \frac{\tau_C\beta}{\hat{S}(1+\chi)(1-\hat{\tau}_Y)}},$$

$$\frac{\partial \tau_Y}{\partial \lambda_t} \equiv \omega_{\lambda} = \frac{\frac{\tau_C}{\hat{S}}}{\nu - \frac{\beta}{1+\chi} + \frac{\hat{S}(1-\nu)}{\hat{S}-1} + \frac{\tau_C\beta}{\hat{S}(1+\chi)(1-\hat{\tau}_Y)}},$$

$$\frac{\partial \tau_Y}{\partial k_t} \equiv \omega_k = \alpha\omega_\lambda = \frac{\alpha\tau_C}{\hat{S}}\eta_\lambda.$$

Given the dynamic system, we can compute the Jacobian matrix of (16) evaluated at the steady state. The trace and determinant of the Jacobian are given by:

$$Tr(J) = \frac{(\rho+\delta)}{a(1-\hat{\tau}_Y)}\{[(1-g)\alpha - (1-\hat{\tau}_Y)a + \frac{a\tau_C}{\hat{S}}]\eta_\lambda + \frac{\rho a(1-\hat{\tau}_Y)}{(\rho+\delta)}\}, \tag{18}$$

$$Det(J) = \frac{(\rho+\delta)^2(\alpha-1)\eta_\lambda}{a(1-\hat{\tau}_Y)}[(1-g) - \frac{a\delta(1-\hat{\tau}_Y)}{(\rho+\delta)} + \frac{a\tau_C}{\hat{S}(\rho+\delta)}] \overset{>}{<} 0 \text{ if } \eta_\lambda \overset{<}{>} 0, \tag{19}$$

In the model there is a jump variable λ_t and a predetermined variable k_t. Thus, local determinacy requires the system to exhibit saddle-point stability in that the two characteristic roots are of opposite signs, i.e., $Det(J) < 0$. However, the equilibrium exhibits indeterminacy if the economy has two roots with negative real parts, i.e., $Det(J) > 0$.[5] In line with Benhabib and Farmer (1996), the economy we consider has relatively modest externalities, i.e., $\alpha = a(1+\theta+\sigma) < 1$. Thus, it is clear from (19) that $\eta_\lambda = \frac{1}{\nu - \frac{\beta}{1+\chi} + \frac{(1-\nu)\hat{S}}{\hat{S}-1} + \frac{\tau_C\beta}{\hat{S}(1+\chi)(1-\hat{\tau}_Y)}} < 0$ is a necessary condition for the steady state to be indeterminate.[6] This condition can nest those in both models of Benhabib and Farmer (1994) as well as Benhabib and Farmer (1996). If we ignore both sectoral externalities ($\theta = 0$ and, hence $\nu = 1$) and taxes ($\tau_C = \tau_Y = 0$), the necessary condition is reduced to $\eta_\lambda = \frac{1+\chi}{1+\chi-\beta} < 0$, which is essentially the Benhabib-Farmer (1994) condition for local indeterminacy. It is also easy to recover the case of Benhabib and Farmer (1996) by setting $\tau_C = \tau_Y = 0$. Under such a situation, the necessary condition turns out to be $\eta_\lambda = \frac{1}{\Gamma} < 0$, where $\Gamma = \nu - \frac{\beta}{1+\chi} + \frac{(1-\nu)\hat{S}}{\hat{S}-1}$.

[5] The equilibrium exhibits a source if the system has two roots with positive real parts.

[6] It follows from (18) and (19) that the necessary and sufficient conditions for local indeterminacy is $\frac{\rho a(1-\hat{\tau}_Y)}{(\rho+\delta)[(1-\hat{\tau}_Y)a-(1-g)\alpha-\frac{a\tau_C}{\hat{S}}]} < \eta_\lambda < 0$.

A particular emphasis is that the necessary condition (19) clearly indicates that in the presence of consumption and income taxes ($\tau_C > 0$ and $\tau_Y > 0$), an effective income tax-cum-consumption tax schedule can reverse the sign of η_λ and hence give rise to the stabilizing effect on the economy against belief-driven fluctuations. Given the government budget constraint (11) (i.e., $\tau_Y = (G_t - \tau_C C_t)/Y_t$), if the income tax-cum-consumption tax schedule satisfies:

$$\tau_C > -\frac{\Gamma \hat{S}(1+\chi)(1-g)}{\beta + \Gamma(1+\chi)}, \tag{20}$$

then the sign of η_λ turns out to be positive. Equation (20) indicates that $\eta_\lambda > 0$ is more likely to be true in the presence of the combination of a higher consumption tax and a lower income tax.[7] It turns out that the economy exhibits saddle path stability and as a result, the equilibrium is locally determinate. That is, an effective consumption tax-cum-income tax schedule can remove indeterminacy caused by aggregate and sectoral externalities. With regard to the stabilizing effect, we will provide more details in our numerical analysis in the next section.

4 Equilibrium Indeterminacy and Income Tax-Cum-Consumption Tax Schedules

This section will perform a simple numerical analysis in order to derive the policy implication of an effective income tax-cum-consumption tax schedule for business cycle fluctuations.

4.1 Benchmark parameterizations

All benchmark parameterizations are summarized in Table 1. Most parameters presented in Table 1 are taken from Benhabib and Farmer (1996). Firstly, we follow Benhabib and Farmer (1996) and set $a = 0.3$, $b = 0.7$, $\rho = 0.05$, and $\delta = 0.1$. Meanwhile, we follow Benhabib and Farmer (1996) and abstract aggregate increasing returns from our numerical analysis, $\sigma = \gamma = 0$. This allows us to more focus our attention on sector-specific externalities. In addition, in conformity with Giannitsarou (2007), the consumption tax rate is set as $\tau_C = 0.06$. Given these parameters, (8'), (9'), (11) and (13) allow us to calibrate $\chi = 1.5$, $\theta = 0.05$, and $g = 0.34124$. These parameterizations imply that $\hat{C}/\hat{Y} = 0.52$, $\hat{P}\hat{I}/\hat{Y} = 0.48$ and $\hat{\tau}_Y = 0.31$. These rates are located within an empirically relevant range of actual data.

[7] To balance the government budget constraint (11), a higher consumption tax must be associated with a lower income tax.

4.2 Numerical analysis: The stabilization policy

Similar to Benhabib and Farmer (1996), in our benchmark parameterization if $Det(J) > 0$, the condition of $Tr(J) < 0$ automatically holds. Therefore, we only show $Det(J)$ in the Figures that follow. First of all, Figure 1 shows that higher sector-specific externalities θ are more likely to generate indeterminacy, as emphasized in Benhabib and Farmer (1996), while a higher rate of consumption tax τ_C is more likely to generate determinacy. To have an effective income tax-cum-consumption tax schedule, a higher consumption tax must be associated with a low income tax τ_Y in order to meet the government's budget constraint (11). In other words, a tax shift away from an income tax towards a consumption tax will stabilize the economy against sunspot fluctuations. Figure 2 provides a clearer graphical approach to our understanding of the stabilizing effect of a tax switch. In Figure 2, the locus GBC traces all combinations of (τ_C, τ_Y) which satisfy the government budget constraint (11). It is clear from Figure 2 that to remove local indeterminacy, the government can implement a tax switch away from an income tax (a decrease in τ_Y) towards a consumption tax (an increase in τ_C) along the GBC locus. The government can design an effective income tax-cum-consumption tax schedule to stabilize the economy against sunspot fluctuations.

In order to glean the intuition for the stabilizing effect of the tax switch, we rewrite the following discrete-time function for ease of illustration:[8]

$$\frac{\Lambda_{t+1}}{\Lambda_t} = \frac{1}{z\left[\frac{a(1-\tau_Y)S_{t+1}}{(1+\tau_C)K_{t+1}\Lambda_{t+1}} + \frac{1-\delta}{\Lambda_{t+1}}\right]}, \tag{21}$$

where $z = 1/(1+\rho)$ is the discount factor and $\frac{a(1-\tau_Y)S_{t+1}}{(1+\tau_C)K_{t+1}}$ (where $\frac{aS_{t+1}}{K_{t+1}} = MPK_{t+1}$ is the marginal product of capital) essentially is the after-tax marginal product of capital at period $t+1$. The economy starts from the steady-state equilibrium at period t. Suppose that agents become optimistic about the future returns on capital, say, the next period's return on capital MPK_{t+1}. In acting upon this belief, the household will sacrifice consumption today C_t for more investment I_t, implying that today's shadow price Λ_t is increased above its steady-state level. This is because today's investment accumulates more capital stock (say, K_{t+1}) and hence increases output (say, Y_{t+1}) in the future. Consequently, the future consumption C_{t+1} increases, referring to a lower shadow price of wealth in the future Λ_{t+1} and, accordingly, the value of the LHS of (21) decreases. In order to stay in equilibrium, the RHS of (21) must also decrease. For ease of illustration, we first ignore taxation ($\tau_C = \tau_Y = 0$) and focus on the case of Benhabib and Farmer (1996). Benhabib and Farmer (1996)

[8] It is easy to derive the intertemporal Euler equation (20) in a discrete-time model. The detailed derivation is available upon request from the authors.

indicate that for generating indeterminacy we need high enough sectoral externalities θ such that $\eta_\lambda = 1/\Gamma = 1/[\nu - \frac{\beta}{1+\chi} + \frac{(1-\nu)\hat{S}}{\hat{S}-1}] < 0$, implying that a lower shadow price of wealth in the future Λ_{t+1} is associated with a larger S_{t+1} in the future. A larger factor share going to the investment sector implies a higher marginal product of capital. As a result, tomorrow's marginal product of capital will increase with tomorrow's capital stock MPK_{t+1} and the agents' expectation will be self-fulfilling. Thus, the steady-state equilibrium is locally indeterminate.

We now consider the government's stabilization policy. By taking the government's tax policy into account, Benhabib and Farmer's (1996) condition turns out to be $\eta_\lambda = \frac{1}{\Gamma + [\tau_C \beta / \hat{S}(1+\chi)(1-\hat{\tau}_Y)]}$. This indicates that the necessary condition for the model to exhibit saddle path stability (local determinacy) is $\eta_\lambda > 0$, or equivalently, $\tau_C > -\frac{\Gamma\hat{S}(1+\chi)(1-g)}{\beta+\Gamma(1+\chi)}$, as reported in (20). If the condition is met, a relevant design of the income tax-cum-consumption tax schedule (i.e., a combination of low income tax and high consumption tax) can overturn the sign of η_λ and, accordingly, remove indeterminacy. That is, if the above condition holds ($\eta_\lambda > 0$) a lower future shadow price of wealth is associated with a lower level of the future S_{t+1}. Given that the reverse of the factor share going to the consumption sector decreases, the future marginal product of capital also decreases, contradicting the intertemporal Euler equation (21). This contradiction invalidates the initial rise in the expected return of capital. Thus, the tax switch that involves tax shifting away from an income tax towards a consumption tax renders the equilibrium determinate.

Why can such a combination of income and consumption taxes stabilize the economy against sunspot fluctuations? When agents anticipate a higher future rate of return on capital, they will reduce consumption for more investment, thus increasing the future capital stock. Meanwhile, with high enough sectoral externalities, the rate of return on capital will rise due to a fall in the relative price of investment goods. Intuitively, to successfully suppress sunspot fluctuations, the government's policy has to prevent agents from cutting consumption for more capital accumulation and to reverse the downward trend in the relative price of investment goods. In the model, tax shifting away from an income tax towards a consumption tax can increase both output and consumption. An increase in τ_C gives rise to a negative effect on consumption, but a reduction in τ_Y gives rise to the wealth effect which raises output and hence consumption as well. In our parameterization, since consumption tax involves less distortion than income tax on economic efficiency, the wealth effect dominates and hence consumption increases followed by such a tax shifting.[9] It turns out that consumption is enhanced and, given a convex PPF, the relative price of investment goods rises in

[9] The previous studies have shown that as a result of a strong wealth effect, the tax switch can increase either the level of output (Chamley, 1985) or the rate of growth (Pecorino, 1993, 1994, and Turnovsky, 2000).

response. As a result, the future marginal product of capital decreases and thus agents' optimistic expectations cannot be realized. It is also important to emphasize that given that tax shifting away from an income tax towards a consumption tax increase both output and consumption, in the model consumption is procyclical in relation to output which is in accordance with the data on business cycles in most countries.

The earlier studies, such as Guo and Lansing (1998) and Christiano and Harrison (1999), have pointed out that in a Benhabib-Farmer-Guo one-sector model progressive taxes stabilize the economy against fluctuations driven by agents' animal spirits, whereas regressive taxes destabilize the economy. However, the wisdom does not apply to a two-sector model with sector-specific externalities. In a calibrated two-sector RBC model with only sector-specific externalities, Guo and Harrison (2001) quantitatively show that a progressive tax no longer serves as an automatic stabilizer, removing sunspot fluctuations and, by contrast, a regressive tax policy stabilizes the economy against sunspot-driven fluctuations. Unfortunately, the required regressive tax policy that Guo and Harrison (2001) find is neither empirically plausible nor observed in the actual data. Under such a situation, the present study serves as an important complement and proposes an alternative policy rule that can remove sunspot fluctuations. Our result suggests that a relevant design of the income tax-cum-consumption tax schedule can do the job. By shifting away from an income tax towards a consumption tax, the government can fully stabilize the economy against sunspot fluctuations even though there exist both aggregate and sector-specific externalities. It is emphasized that since either a single constant income tax rate or a single constant tax consumption tax rate cannot have a stabilizing effect to suppress sunspot fluctuations, a relevant combination of income and consumption taxes is needed.

As noted in the Introduction section, the tax reform involving a switch from a decrease in income tax to an increase in consumption tax has been an important issue in public finance and macroeconomics over the past three decades. This is because a consumption tax involves less distortion than an income tax and it could eliminate the bias against investment and savings inherent in the income tax system (see Summers, 1981, Abel and Blanchard, 1983, Auerbach et al., 1983, and Chamley, 1985). Given that, we can propose that in addition to the efficiency improvement, a tax switch away from an income tax towards a consumption tax can also serve as a stabilization policy against sunspot fluctuations.

5 Concluding Remarks

By extending the analysis of Benhabib and Farmer (1996), this paper has revisited the issue of aggregate instability arising from animal spirits. In a calibrated two-sector RBC model with only sector-specific externalities, Guo and Harrison (2001) have quantitatively shown that a progressive tax no longer serves as an automatic stabilizer, removing sunspot fluctuations. By contrast, a regressive tax policy can stabilize the economy against sunspot-driven fluctuations. However, the required regressive tax policy that Guo and Harrison (2001) find is not observed in the actual data. To fill this void in the literature, this paper has explored an alternative policy rule that can remove sunspot fluctuations. Our analysis has shown that to stabilize the economy against sunspot fluctuations, the government can design an effective income tax-cum-consumption tax schedule which involves a tax switch away from an income tax towards a consumption tax. This finding has potentially pointed out that in addition to its efficiency improvement, a tax switch away from an income tax towards a consumption tax can also serve as a stabilization policy against sunspot fluctuations.

Weder (2001), Meng and Velasco (2003, 2004) show that in a two-sector small open economy, the condition for local indeterminacy can be satisfied more easily than in a closed economy. In other words, a small open economy is more likely to confront aggregate instability arising from animal spirits. Thus, it is also interesting to extend our model to a small open economy one. The extended analysis will enable us to examine whether a tax switch away from an income tax towards a consumption tax is still effective, being capable of fully insulating the small open economy from belief-driven fluctuations.

References

[1] Abel, A. B. and O. J. Blanchard, 1983, "An Intertemporal Model of Saving and Investment," Econometrica 51, 675-692.

[2] Atkinson, A. and J.E. Stiglitz, 1976, "The design of tax structure: Direct versus indirect taxation," Journal of Public Economics 6, 55-75.

[3] Auerbach, A. J., L. J. Kotlikoff, and J. Skinner, 1983, "The Efficiency Gains from Dynamic Tax Reform," International Economic Review 24, 81-100.

[4] Barro, R.J., 1990, "Government Spending in a Simple Model of Endogenous Growth," Journal of Political Economy 106, 407-444.

[5] Benhabib, J. and R. Farmer, 1994, "Indeterminacy and Increasing Returns," Journal of Economic Theory 63, 19-41.

[6] Benhabib, J. and R. Farmer, 1996, "Indeterminacy and Sector-Specific Externalities," Journal of Monetary Economics 37, 421-444.

[7] Bond, E., P. Wang, and C. Yip, 1996, "A General Two-Sector Model of Endogenous Growth with Human and Physical Capital: Balanced Growth and Transitional Dynamics," Journal of Economic Theory 68, 149-173.

[8] Chamley, C., 1985, "Efficient Tax Reform in a Dynamic Model of General Equilibrium," Quarterly Journal of Economics 100, 335-356.

[9] Christiano, L. and S. Harrison, 1999, "Chaos, Sunspots, and Automatic Stabilizers," Journal of Monetary Economics 44, 30-31.

[10] Devereux, M. and D. Love, 1995, "The Dynamic Effects of Government Spending Policies in a Two-Sector Endogenous Growth Model," Journal of Money, Credit and Banking 27, 232-256.

[11] Dromel, N. L. and P. A. Pintus, 2007, "Linearly Progressive Income Taxes and Stabilization," Research in Economics 61, 25-29.

[12] Dromel, N. L. and P. A. Pintus, 2008, "Are Progressive Income Taxes Stabilizing?" Journal of Public Economic Theory 10, 329-349.

[13] Farmer, R. and J. T. Guo, 1994, "Real Business Cycles and the Animal Spirits Hypothesis," Journal of Economic Theory 63, 42-72.

[14] Giannitsarou, C., 2007, "Balanced Budget Rules and Aggregate Instability: The Role of Consumption Taxes," Economic Journal 117, 1423-1435.

[15] Grandmont, J.-M., 1986, "Stabilizing competitive business cycles," Journal of Economic Theory 40, 57–76.

[16] Guo, J. T. and S. G. Harrison, 2001, "Indeterminacy with Capital Utilization and Sector-specific Externalities," Economics Letters 72, 355-360.

[17] Guo, J. T. and K. Lansing, 1998, "Indeterminacy and Stabilization Policy," Journal of Economic Theory 82, 481-490.

[18] Meng, Q. and A. Velasco, 2003, "Indeterminacy in a Small Open Economy with Endogenous Labor Supply," Economic Theory 22, 661-669.

[19] Meng, Q. and A. Velasco, 2004, "Market Imperfections and the Instability of Open Economies," Journal of International Economics 64, 503-519.

[20] Pecorino, P., 1993, "Tax Structure and Growth in a Model with Human Capital," Journal of Public Economics 52, 251-271.

[21] Pecorino, P., 1994, "The Growth Rate Effects of Tax Reform," Oxford Economic Papers 26, 492-502.

[22] Reichlin, P., 1986, "Equilibrium cycles in an overlapping generations economy with production," Journal of Economic Theory 40, 89–102.

[23] Summers, L. H., 1981, "Capital Taxation and Accumulation in a Life Cycle Growth Model," American Economic Review 71, 533-544.

[24] Turnovsky, S. J., 2000, "Fiscal Policy, Elastic Labor Supply, and Endogenous Growth," Journal of Monetary Economics 45, 185-210.

[25] Wang, P. and C. Yip, 1995, "Macroeconomic Effects of Factor Taxation with Endogenous Human Capital Evolution: Theory and Evidence," Southern Economic Journal 61, 803-818.

[26] Weder, M., 2001, "Indeterminacy in the Small Open Economy Ramsey Growth Model," Journal of Economic Theory 98, 339-356.

Definition	Parameter	Value	Source
Capital share	a	0.3	Benhabib and Farmer (1996)
Labor share	b	0.7	Benhabib and Farmer (1996)
Sector-specific externality	θ	0.05	Calibration
Discount parameter	ρ	0.05	Benhabib and Farmer (1996)
Depreciation rate of capital	δ	0.1	Benhabib and Farmer (1996)
Inverse of the labor supply elasticity	χ	1.5	Calibration
Consumption tax rate	τ_C	0.06	Giannitsarou (2007)
Government expenditure-output ratio	g	0.34124	Calibration

Table 1. Benchmark parameter values

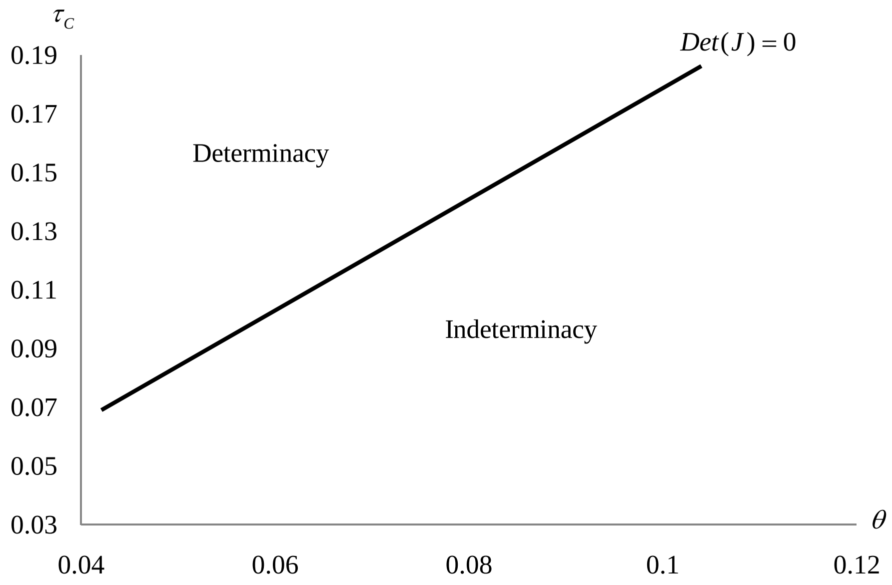

Figure 1. (In)Determinacy in the (τ_C, θ) space

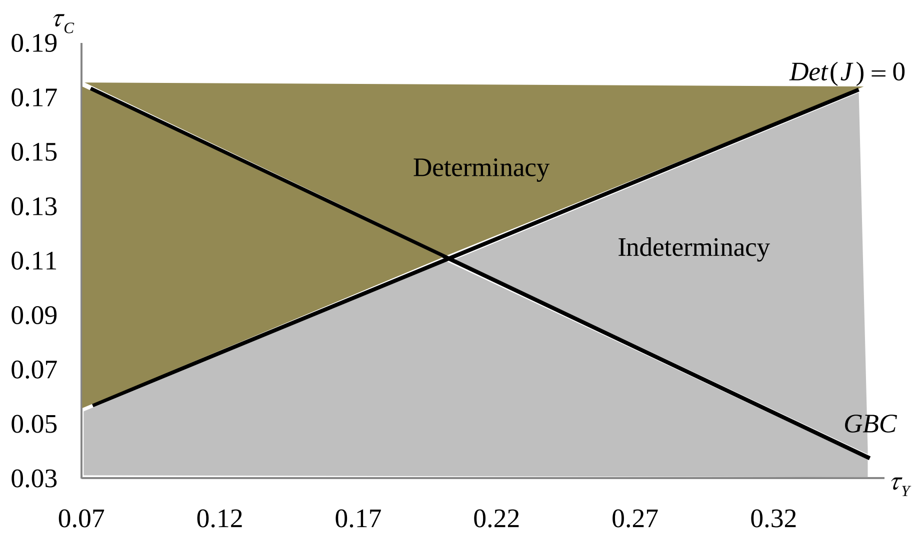

Figure 2. (In)Determinacy in the (τ_C, τ_Y) space